

# **THERMAL INTEGRATION OF CO<sub>2</sub> COMPRESSION HEAT TO IMPROVE POWER PLANT HEAT RATE**

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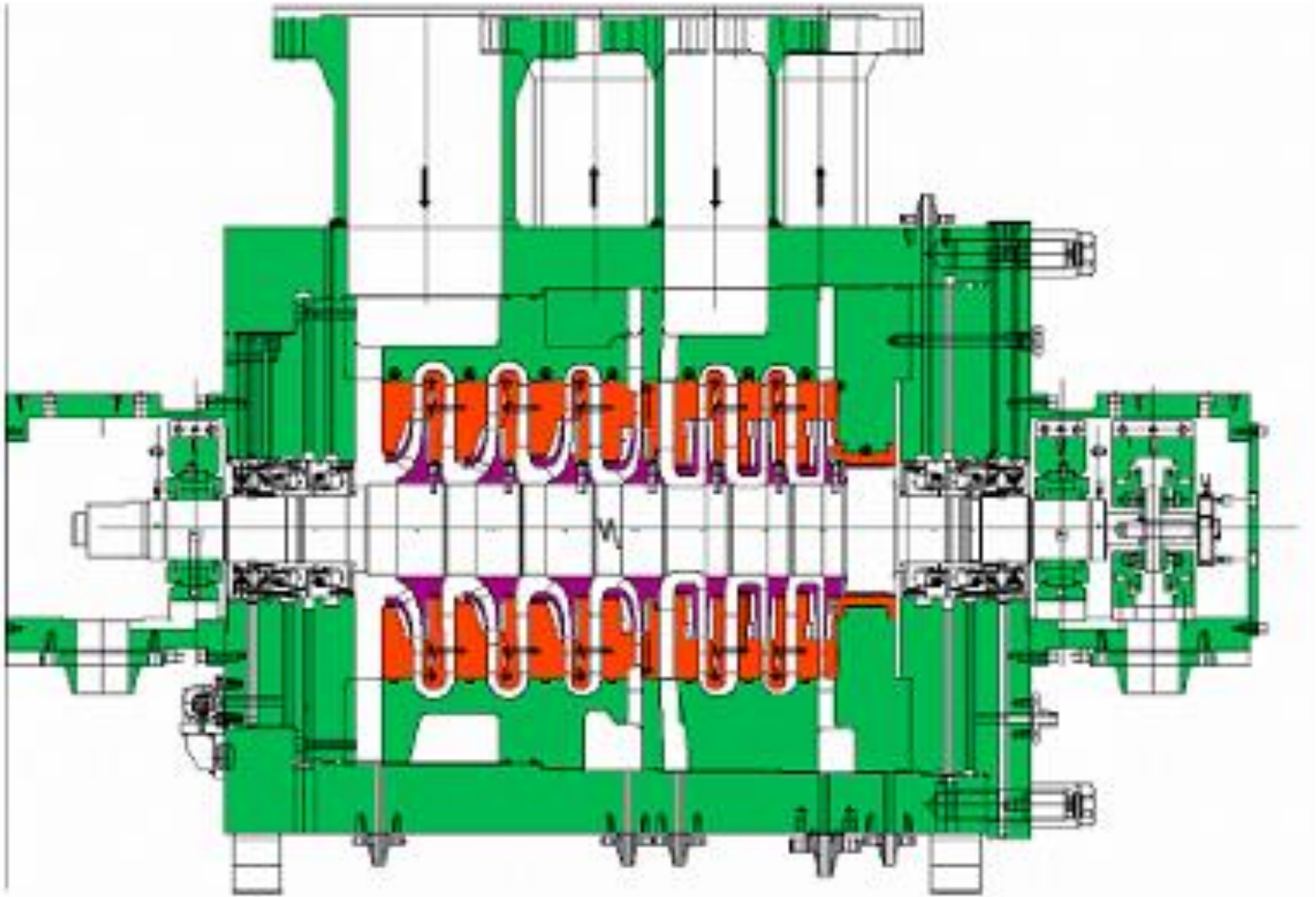
**Energy Research Center  
Lehigh University  
Bethlehem, PA**

**2011 NETL CO<sub>2</sub> Capture Technology Meeting**

# CO<sub>2</sub> COMPRESSION

- **Compress from suction pressure of 14.7 to 300 psia to a discharge pressure greater than 2200 psia**
- **CO<sub>2</sub> flow rates ~ 1 million lbm/hr**
- **Will add parasitic load and reduce unit efficiency**
- **Opportunities for thermal integration innovations**

# INLINE COMPRESSOR



# INLINE AND INTEGRALLY GEARED COMPRESSORS

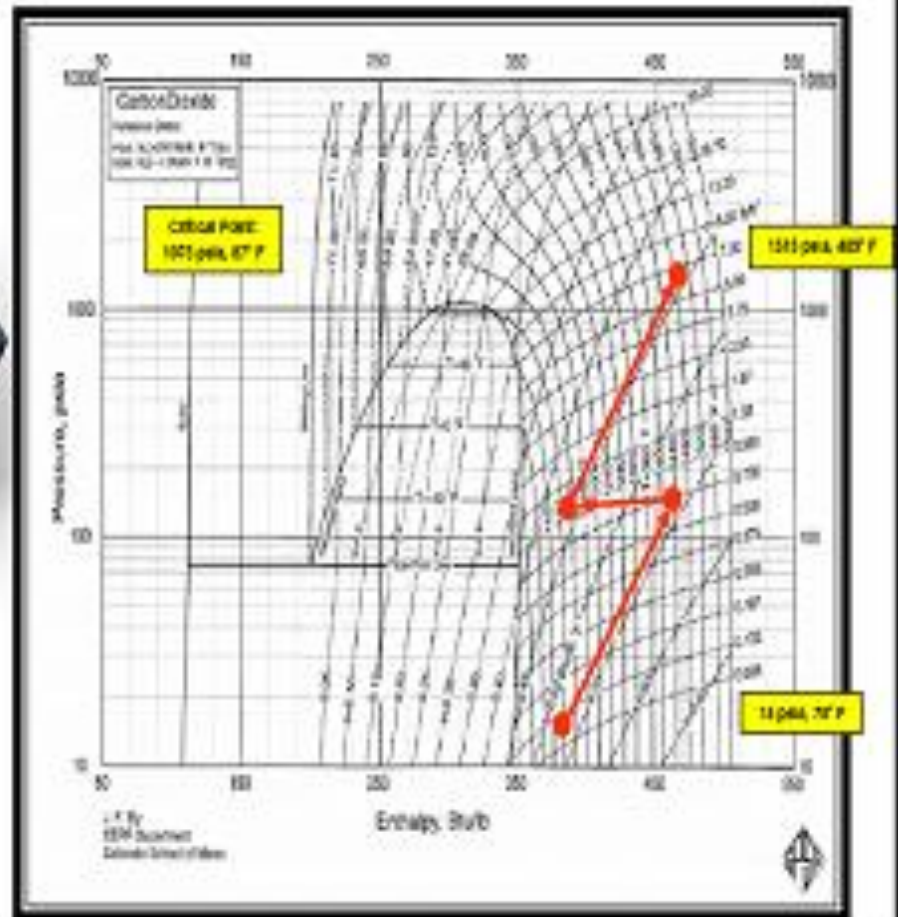




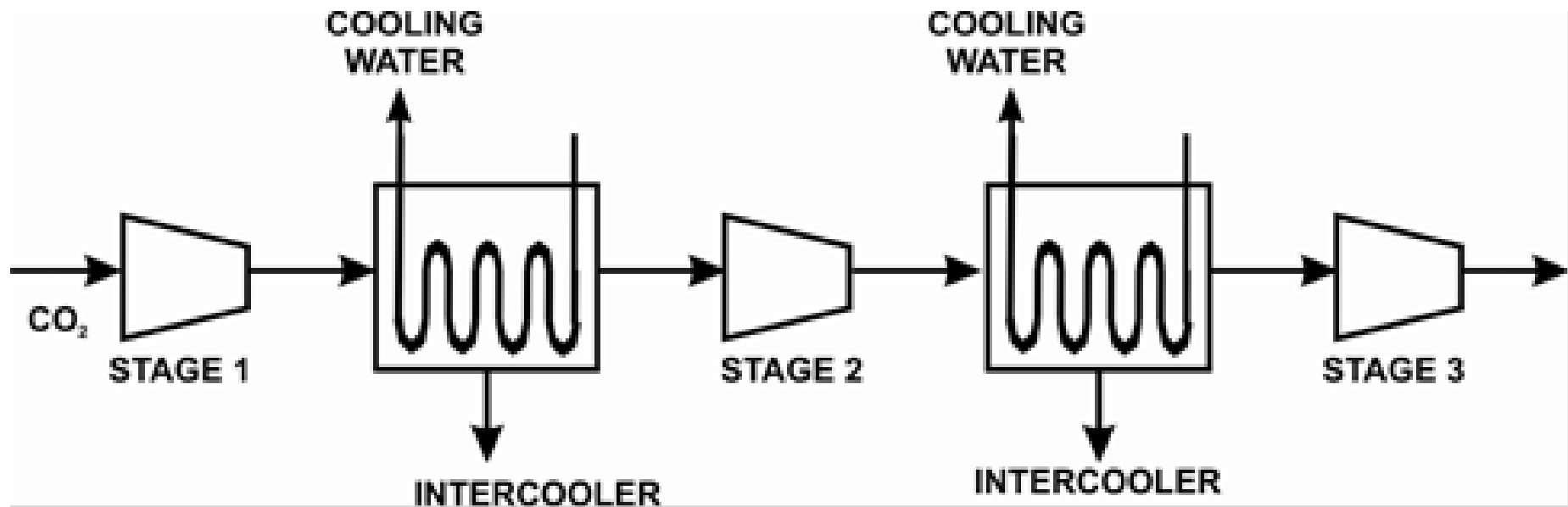
# RAMGEN COMPRESSOR



Ramgen Discrete Drive HP Stage

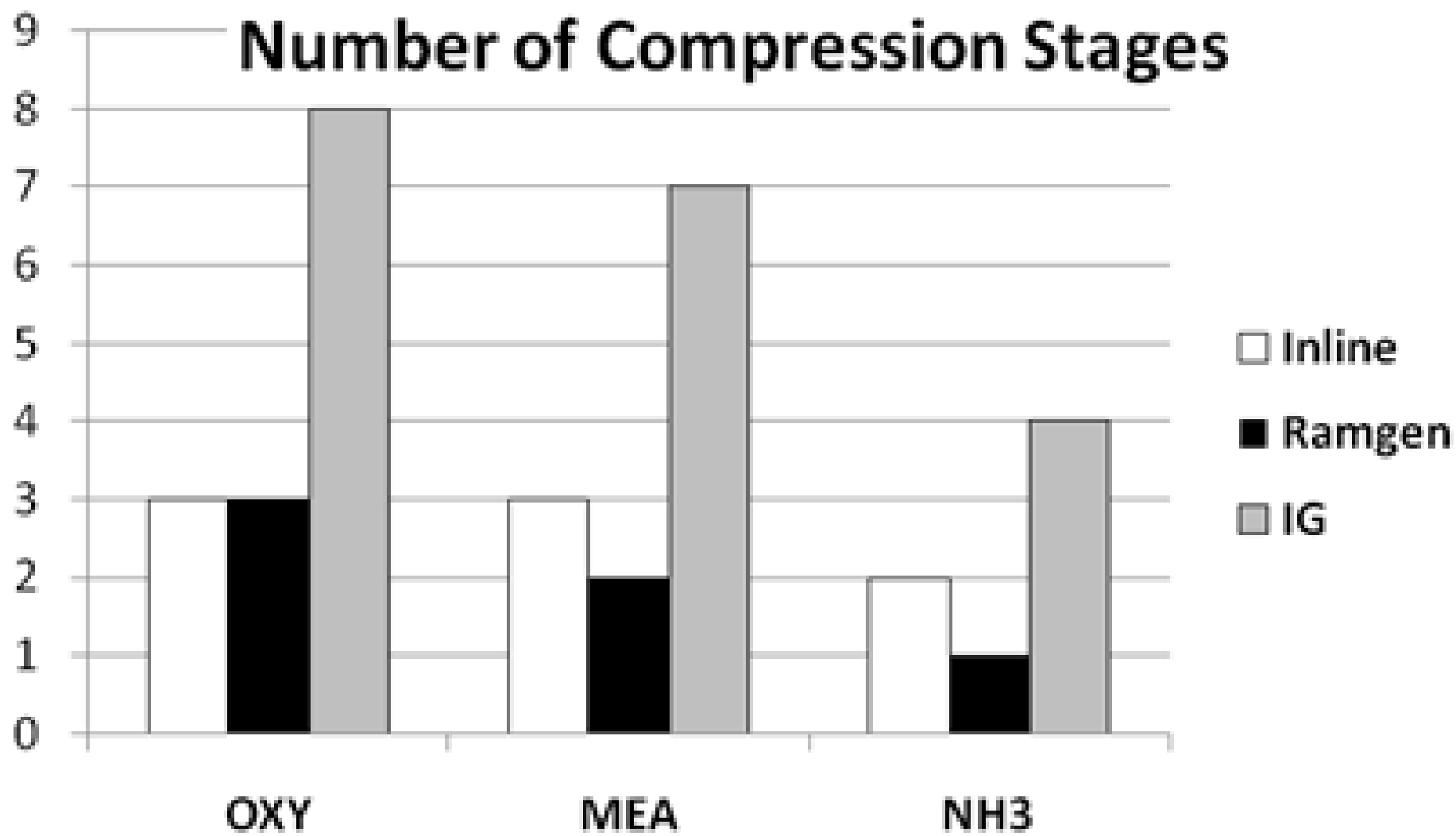


# INTERCOOLING NEEDED BETWEEN STAGES



# TYPICAL STAGE PRESSURE RATIOS

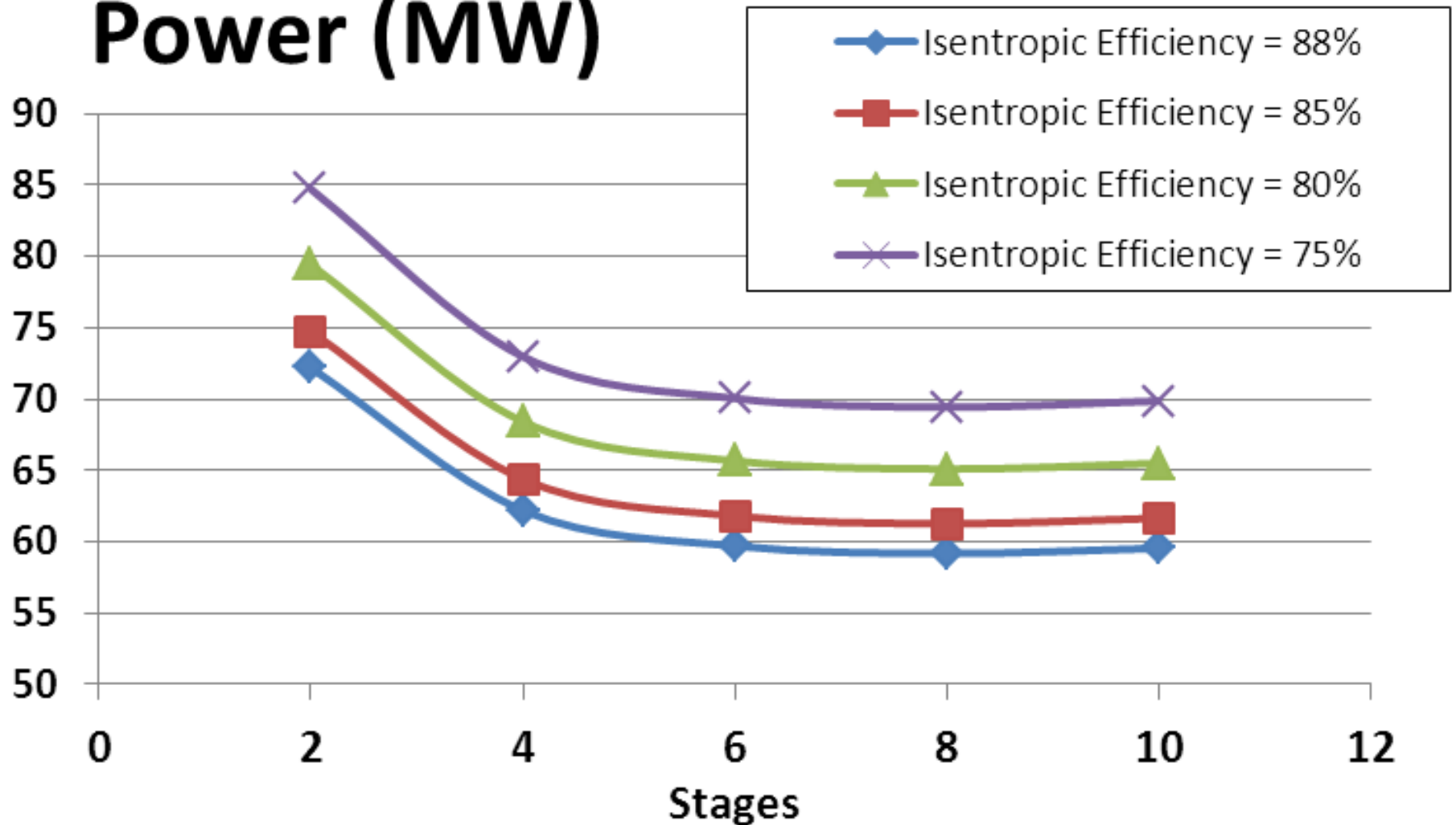
- **Inline** **2 to 6**
- **Integrally Geared** **1.5 to 2.5**
- **RAMGEN** **10**





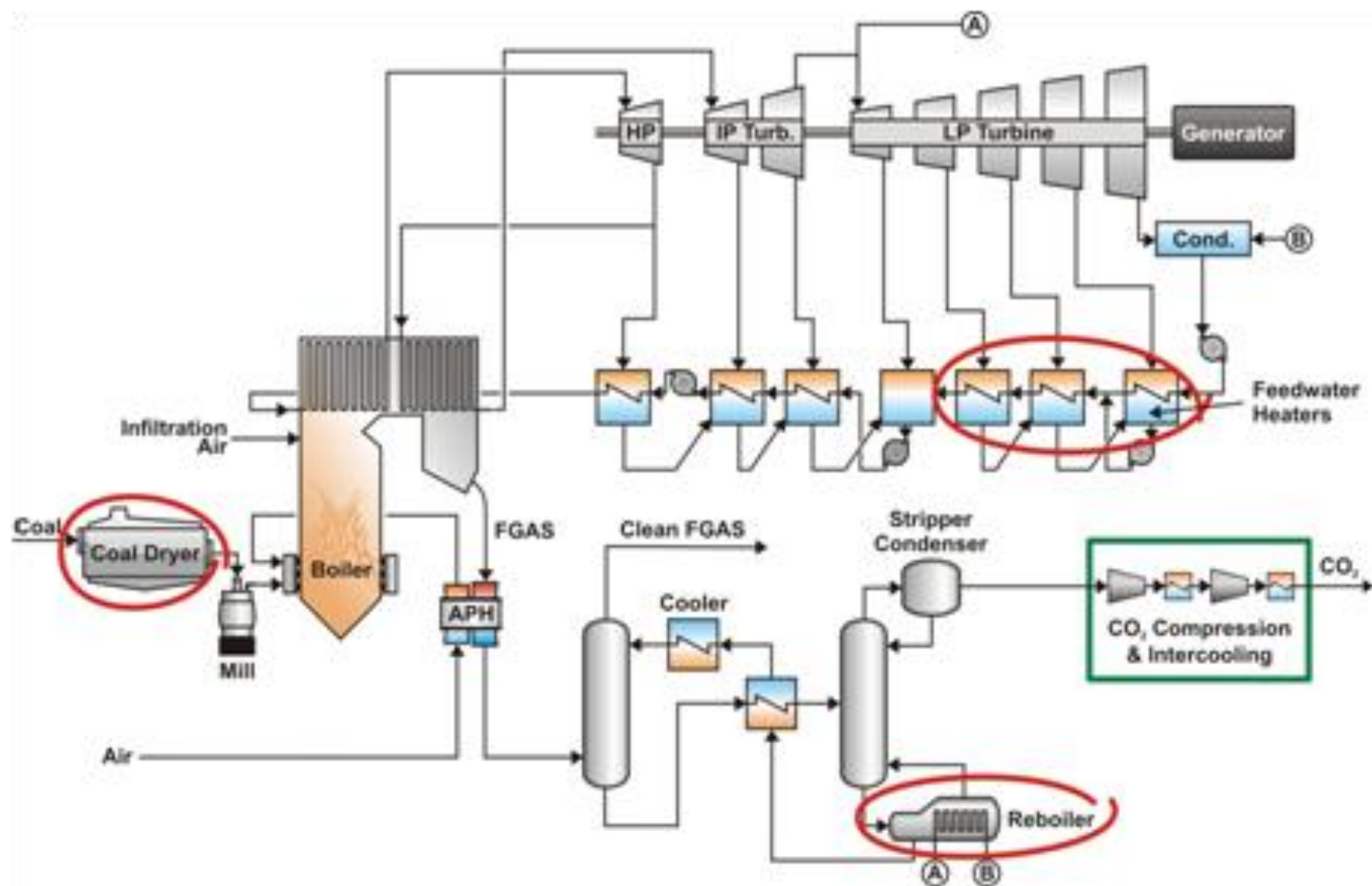
# EFFECTS OF STAGE EFFICIENCY AND NUMBER OF STAGES: OXYCOMBUSTION

**Power (MW)**

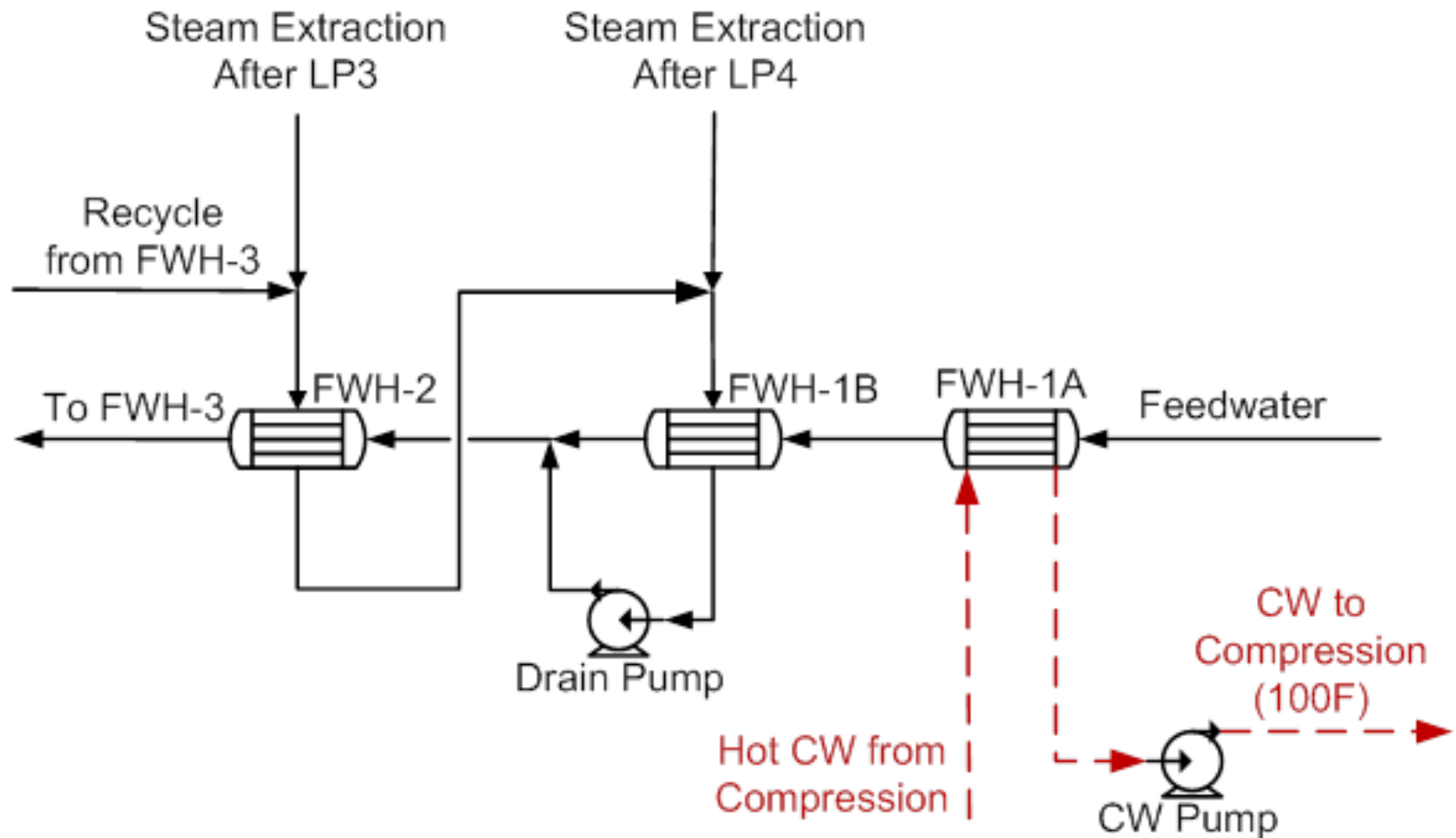


# **POWER PLANT SIMULATIONS**

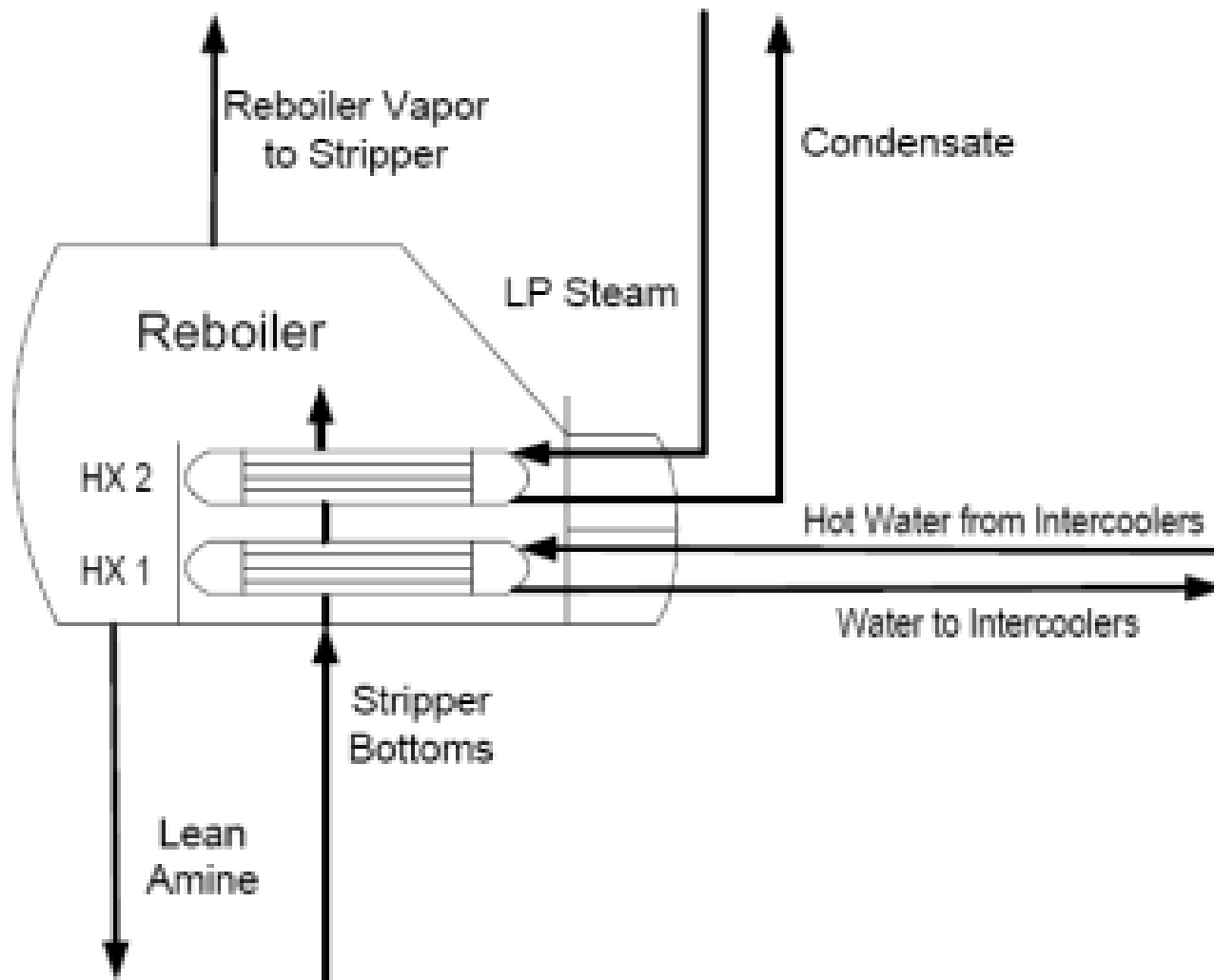
- **Used ASPEN Plus to model a 600 MW supercritical pulverized coal steam power plant firing PRB coal**
- **Developed separate models for MEA, chilled ammonia and oxycombustion capture systems**
- **Included compressors and coolers into models**



# FEEDWATER HEATER INTEGRATION

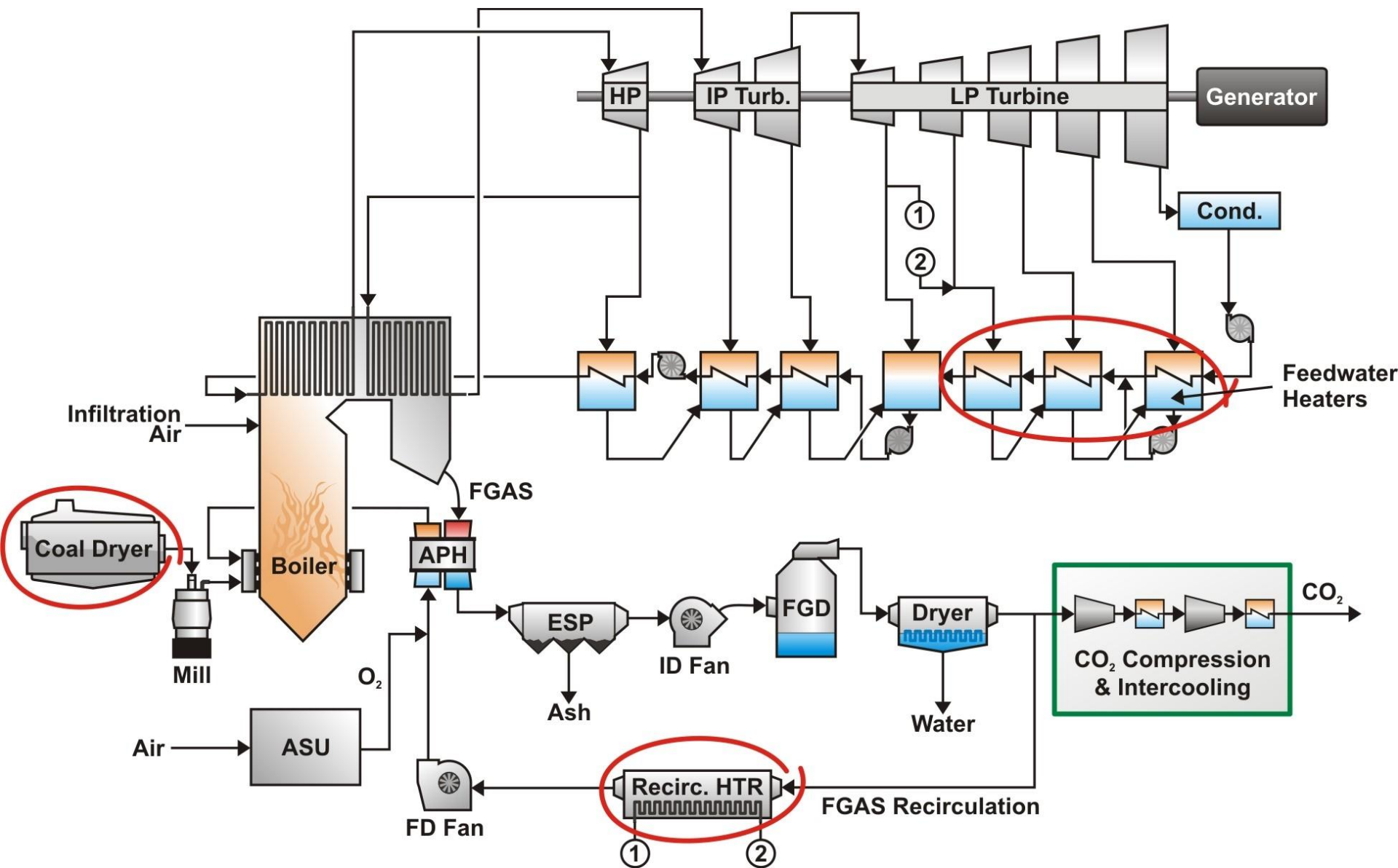


# STRIPPER REBOILER



# MEA SCRUBBER, PRB COAL, INLINE COMPRESSOR

Thermal Integration Cases	$\Delta$ HR (%)
Compressor Heat to FWH3, FWH2 and FWH1	-2.32
Compressor Heat to FWH5	-3.03
Compressor Heat to Coal Dryer	-3.84
Stripper Condenser to Coal Dryer	-3.85
Compressor Heat to Reboiler	-2.42
Stripper Condenser to FWH3, FWH2, and FWH1	-3.76
Stripper Condenser to FWH3, FWH2, and FWH1 Compressor Heat to Reboiler	-5.99
Condenser to FWH3,2,1 Compressor Heat to FWH4,5	-6.27





# OXYFIRING, PRB COAL, INLINE COMPRESSOR

Thermal Integration Cases	$\Delta$ HR
Recirculated Flue Gas Heating	-0.83%
Coal Drying	-3.72%
Replace FWH 1 Extraction	-1.02%
Replace FWH 2 Extraction	-1.24%
Replace FWH 3 Extraction	-1.36%
Replace FWH 1 & 2 Extraction	-2.25%
Recirc. Heating, Coal Drying & Replace FWH 1 Extraction	-5.37%
Recirc. Heating, Coal Drying & Replace FWH 2 Extraction	-5.63%
Recirc. Heating, Coal Drying & Replace FWH 3 Extraction	-5.81%

# **SUMMARY/CONCLUSIONS**

## **PRB COAL AND INLINE COMPRESSOR:**

- **Oxy-fired Unit: Thermal Integration of Compressor Heat**

**Delta Heat Rate up to 5.8 %**

- **MEA Capture System: Thermal Integration of Compressor Heat & Stripper Condenser Heat**

**□ Delta Heat Rate Up To 6.3 %**

# NEXT STEPS

- **Compare Types of Compressors**
- **Perform Analyses for Lignite and Bituminous Coals**
- **Comparative Analysis of Different Capture Systems and Differences Between Integration Strategies**

# ACKNOWLEDGEMENTS

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